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**NUCLEAR
ENERGY
for the
OIL SANDS**

An Opportunity for Alberta

DPN 7358991



The massive oil sands deposits in Alberta represent one of the largest petroleum resources in the world. So vast are these reserves that the oil locked in them could satisfy Canada's petroleum needs for at least the next century.

Important benefits of oil sands development include reduced foreign oil imports, improved national balance of payments, more jobs and more tax revenue.

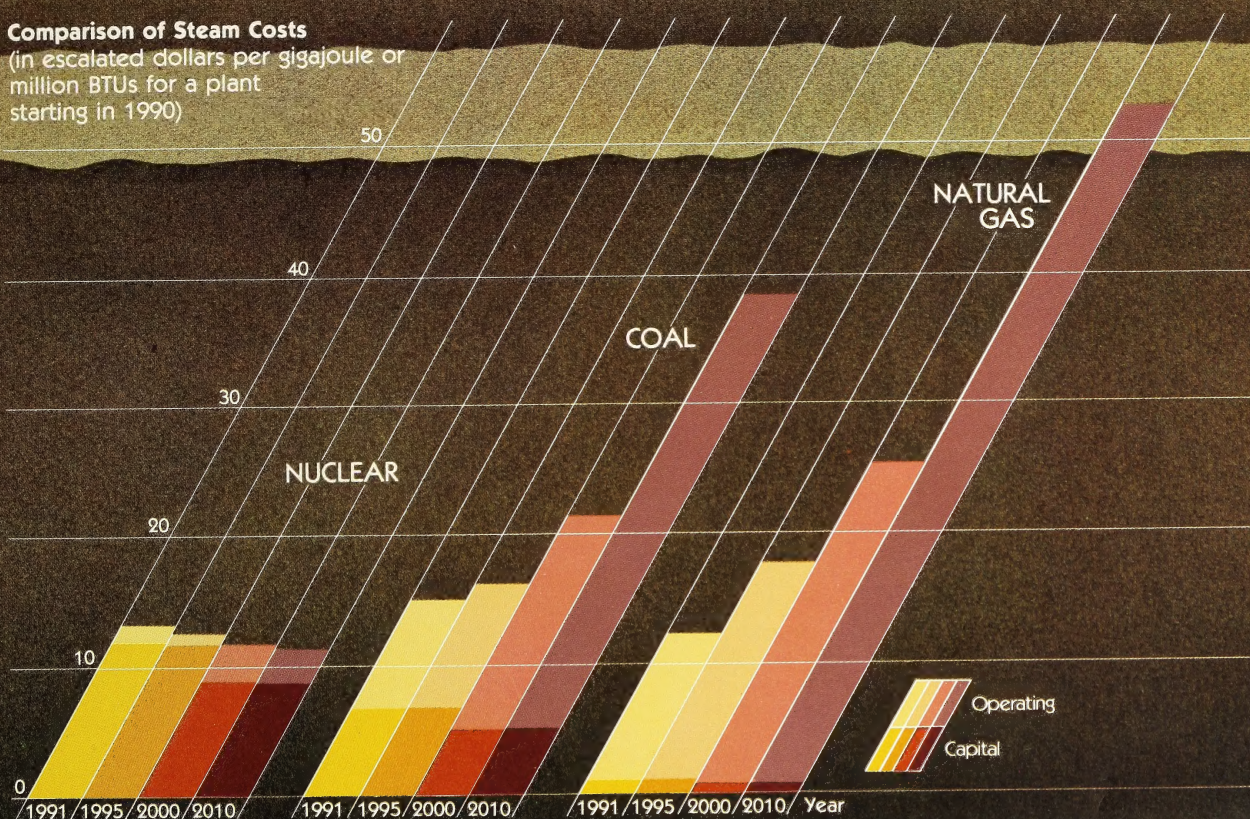
While some of this resource can, and is, being recovered by surface mining techniques, most can be extracted only by using in-situ methods. The method with the most potential uses high pressure steam to lower the viscosity of the bitumen so that it can be pumped to the surface. Steam for this purpose can be generated using coal, natural gas, nuclear energy or a portion of the recovered bitumen itself.

The Study

In 1981, a team comprised of **Atomic Energy of Canada Limited; Alberta Power Limited; NOVA, An Alberta Corporation; and Petro-Canada** initiated a study to examine the use of nuclear energy in the oil sands. The purpose of the first phase of this study was to assess the technical and economic feasibility of using CANDU reactors to provide the steam needed for the in-situ recovery of bitumen from the Alberta oil sands. The results show that nuclear energy offers substantial cost savings over the alternatives and therefore has great potential for use in the oil sands.

Comparison of Steam Costs

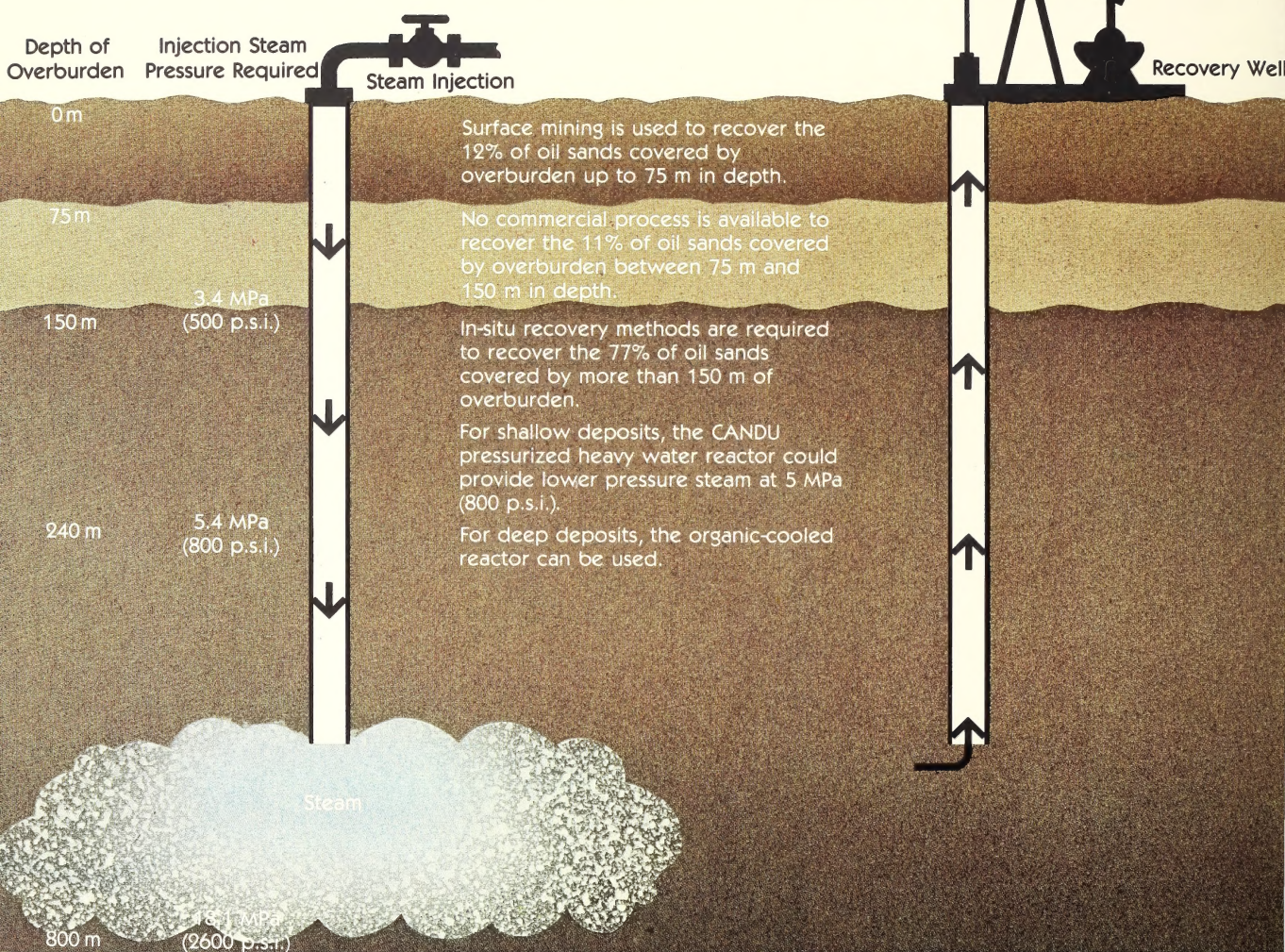
(in escalated dollars per gigajoule or million BTUs for a plant starting in 1990)



Why Nuclear Energy for the Oil Sands

- A comparison of steam costs over the life of an oil sands plant started up in 1990 indicates that steam produced from nuclear energy is substantially more economical than that from other sources: (See graph above for the comparison of steam costs using coal, natural gas and nuclear energy.)
- Increasing the economic viability of oil sands projects can assist in bringing them on stream more rapidly, thus benefiting the Alberta economy.
- Nuclear-generated steam, using uranium as the heat source, will conserve fossil fuels for alternate uses.
- Nuclear-generated steam will reduce the environmental impact of oil sands development.
- The application of nuclear energy in the oil sands will result in the development of another high technology industry in Alberta.
- The package of nuclear/oil sands technology offers Canadian business opportunities abroad.

Recovery Methods for Alberta Oil Sands



The Nuclear Option

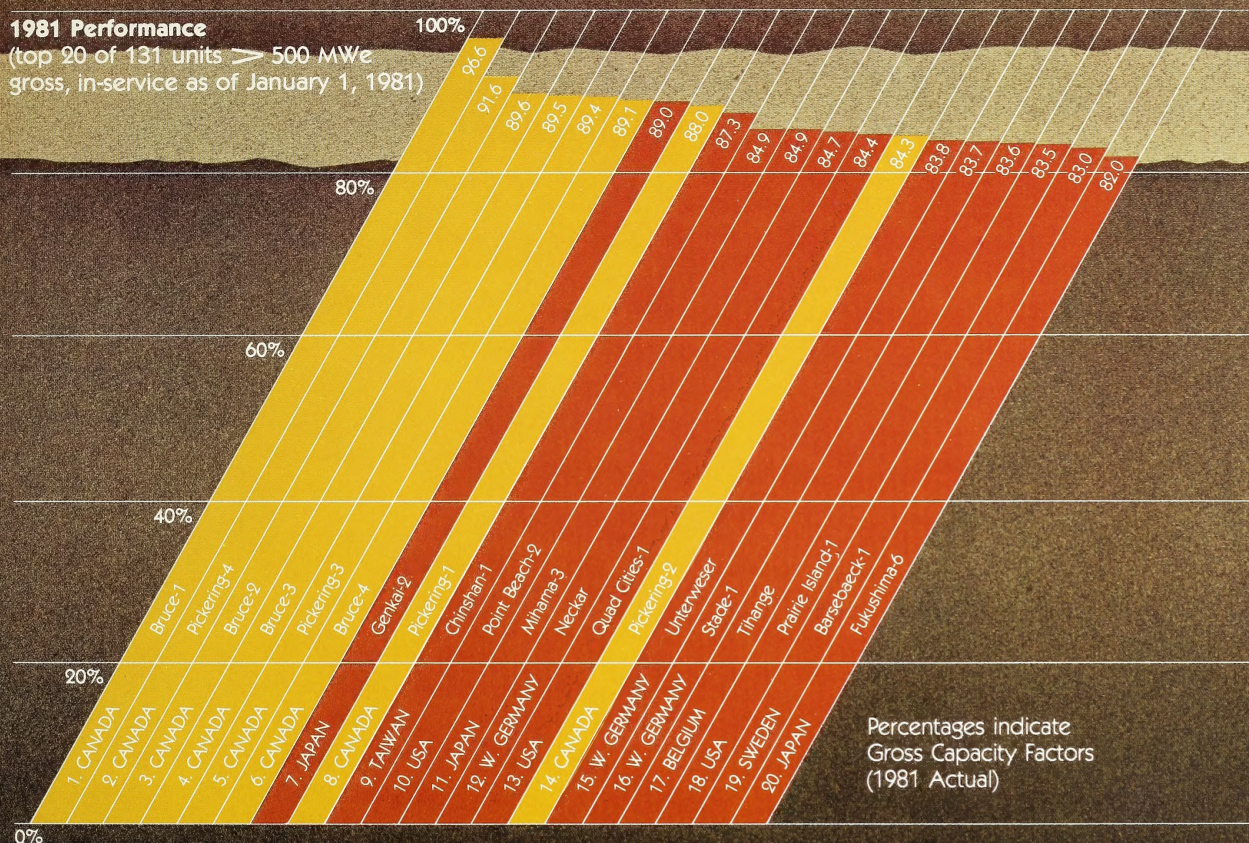
The Alberta participants in the study are primarily interested in developing more economical methods for extraction of the oil and in supplying the large energy requirements of these megaprojects. Atomic Energy of Canada Limited, designers and developers of Canada's nuclear program, wish to encourage the application of Canada's world-class nuclear power technology to an expanded domestic and foreign market.

Nuclear steam on a massive scale (comparable to that required for an oil sands plant) is already being used for chemical processing and heating purposes by Ontario Hydro at the Bruce Nuclear Power Development. Plans are well advanced to extend this

steam supply to the 2000-acre Bruce Energy Centre, thereby providing steam at low cost to other industrial users. This project is being actively promoted by the Government of Ontario.

- For shallow oil sands deposits, lower pressure steam at less than 5 MPa (800 p.s.i.) can be provided by the commercially proven CANDU pressurized heavy water reactor.
- For deep oil sands deposits, high pressure steam can be provided by the organic-cooled reactor that has been performance proven by 15 years operation as a research reactor at Pinawa, Manitoba.

1981 Performance
(top 20 of 131 units > 500 MWe
gross, in-service as of January 1, 1981)



The success to date of Canada's nuclear power reactors is illustrated above. In 1981, CANDU reactors accounted for 35% of Ontario's electrical power production.

World Power Reactor Performance

Canadian nuclear reactors occupied the top six positions in the 1981 world performance rankings of reactors over 500 MW electrical.

The ratings are based on the reactor's actual operating performance expressed as a percentage of its designed capability (that is if it ran uninterrupted at full power for one year).

Even more important than that annual performance is the lifetime performance — since the reactor went into service. Here, seven of the top 10 are Canadian reactors, which had operated for a total of 49 years by January 1982 with an average lifetime operating performance of more than 80%.



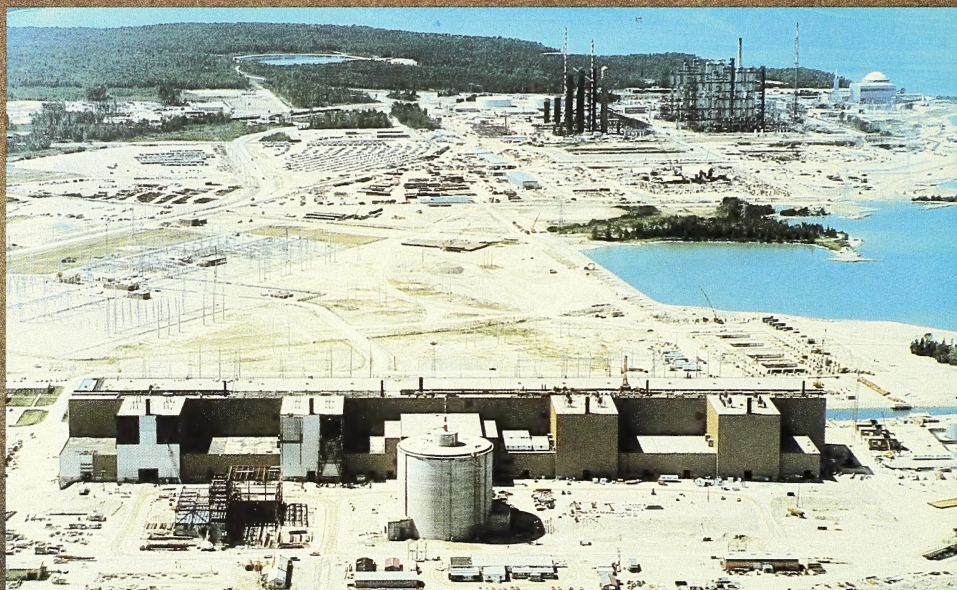
Important Conclusions of the Initial Study

- The use of nuclear energy is technically and economically sound for the in-situ recovery of bitumen from the oil sands.
- Over the life of an oil sands project, a nuclear-generated steam supply offers a 25-50% cost advantage over one based on coal and even a greater advantage over one based on natural gas.
- The economic benefit offered by a nuclear steam supply system is large enough to justify the next level of commitment and analysis.
- Alberta industry, with its experience and expertise in the technology and economics of oil sands recovery, is in a position to take an active leadership role in this project and to share in the benefits.



Where Do We Go from Here ?

Phase II of the study is scheduled to be carried out over the next two years at a cost of about \$4 million. A broad scope of economic, technical and social factors will be analysed. Activities will include conceptual design work on the nuclear steam supply system, a design and cost analysis of its integration with the whole oil sands project, assessment of environmental and social impact and identification of opportunities for industry, both immediate and long term, at home and abroad.

**For more information contact**

Al Bancroft
Atomic Energy of Canada Limited
Chalk River Nuclear Laboratories
Chalk River, Ontario K0J 1J0
Tel. (613) 584-3311
Telex 053-34555

Alex Mayman
Atomic Energy of Canada Limited
Whiteshell Nuclear
Research Establishment
Pinawa, Manitoba R0E 1L0
Tel. (204) 753-2311
Telex 07-57553